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Human-centered Artificial Intelligence Development

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ABSTRACT

Few researchers provide a wider vision of artificial feet, hands, mouths, eyes, ears, and brains. This limits our vision of them and their significant impacts on the modern Industrial Revolution and Artificial Intelligence (AI) history. This article presents a novel perspective on human-centered social development starting from artificial feet. After briefly reviewing AI, this article explores the age of AI and artificial feet, hands, mouths, eyes, ears, and brains. It also applies AI to artificial feet and artificial brains. The research reveals that artificial feet are one of the origins of the Industrial Revolution and a real foundation of AI. The study demonstrates that artificial feet and brains liberate our body and society, whereas from artificial brains to artificial feet is control of our body and society. This article also looks at AI's trends and challenges. The approach in this article will facilitate the research and development of big data, analytics, and intelligences.

Keywords: Artificial intelligence; Cloud computing; Artificial feet; Generative AI

1. Introduction

Intelligence is not only a lasting topic for computer science, AI, intelligence computing, business intelligence (BI), and intelligent analytics, but also an exciting topic for industries, organizations, and businesses [1]. AI has facilitated the development of intelligent services, intelligent manufacturing, intelligent systems [2], intelligent chips, and intelligent analytics [3]. BI has improved competitive business and marketing performance, supported management decision-making of organizations, and produced trillion-level enterprises such as Google, Amazon, and

Meta [4]. However, the current AI is very mixed and very market-driven. A lot of companies brand their products as AI products. Many social media brands do things as AI products and services.

The age of AI can go back to 1950 when Alan Turing published his seminal article titled 'Computing Machinery and Intelligence' [5]. AI was first coined by John McCarthy in 1956, defined as the "science and engineering of making intelligent machines" [6]. It aims to imitate, extend, augment, simulate, and automate intelligent behaviors of human beings using computing machinery [2,7]. In the past seven decades, researchers and developers have been working on the intelligence of machines, neural networks, machine learning and translation, natural language processing, machine translation, expert systems, knowledge base systems, fuzzy logic and systems, genetic algorithms, and so on under the flagship of AI [2,8,9].

The age of AI has officially arrived in 2013 [10]. The significant success and global concern of market-driven AI are another reason for the coming of the age of AI. Autonomous vehicles, advanced vision systems, virtual customer assistants, smart personal agents, and natural language processing including ChatGPT are all advanced technologies of market-driven AI [11,12]. Google and Baidu driverless cars running on the road in the USA and China symbolize the significant progress of market-driven AI. Smartphones are intelligent products that provide health analytics, weather, shopping, and travel services wherever and whenever one is.

However, have you found an artificial leader who is leading a country? In fact, artificial leadership is the ultimate goal of AI, robots, intelligent agents, digital workforces, and robotic process automation [13]. Therefore, the biggest change for these research fields is how to create an artificial leader to win the national election in a state to become the national president. This creation requires first knowing artificial feet because the journey of manufacturing artificial leaders begins with a single step of artificial feet, just as "a journey of a thousand miles begins with a single step of feet", a Chinese proverb said.

However, there are still a lot of research issues that have not drawn significant attention, for example,

a) What is the relationship between basic intelligence, intelligence 1.0, and 2.0?
b) What is the intelligence of our body?
c) What are artificial feet and artificial heads?
d) How can we apply AI to artificial feet and artificial brains?

This article will address these four issues. To address the first issue, this article looks at the fundamentals of basic intelligence and then explores intelligence 1.0 and intelligence 2.0. To address the second issue, this article examines the intelligence of the five senses and our body. To address the third issue, this article looks at artificial feet and artificial heads. To address the fourth issue, this article investigates how to apply AI to artificial feet and artificial brains. Finally, this article examines AI's trends and challenges for the years to come. The final sections will end this article by providing conclusions and some future work.

The remainder of this article is structured as follows: Section 2 looks at the fundamentals of basic intelligence; it explores intelligence 1.0 and intelligence 2.0, Section 3 reveals the intelligence of the five senses and our body. Section 4 looks at artificial feet and artificial heads, Sections 5 and 6 examine AI's trends and challenges, and Section 7 ends this article by providing conclusions and some future work.

2. Basic intelligence, intelligence 1.0 and 2.0

This section looks at the fundamentals of basic intelligence; it explores intelligence 1.0 and 2.0.

2.1 Basic Intelligence

Intelligence is the ability to "learning, thinking, and understanding" [14]. These three abilities are the core of basic human intelligence. Machine learning including deep learning aims to automate the ability of human learning by "improving the performance on future tasks after making observations about the world" [2] and then improve the ability of learning of

humans, machines, and systems. One of the first digital machines is the perceptron, a US Navy-funded attempt at building a thinking and learning machine led by Frank Rosenblatt [2]. The goal of the perceptron, which debuted in 1957, was to classify things it saw. However, persistence with perceptrons paid off because of the success of AlphaGo in 2016. AI has finally fulfilled at least some of its early promise. Only learning, thinking, and understanding are not enough in modern society, connecting should be another component of human intelligence. Advanced communication technologies and tools such as mail, telephone, email, social media, and information sharing on the Web aim to develop the skill of connecting (via communication) as a form of intelligence. For example, the current advanced ICT technology and systems [13,15] have brought about social networking services such as Facebook, TikTok, WeChat, and WhatsApp. All these have developed the skill of connecting as a part of intelligence, that is, connecting intelligence (e.g., human intelligence).

Therefore, intelligence consists of the ability to learn, think, understand, and connect.

2.2 Intelligence 1.0

Early AI focuses on the simulation and automation of human intelligence 1.0, that is, the ability to "learn, think, understand, and connect". For example, machine learning, deep learning in AI is a kind of data learning.

Machine learning (ML) is about how to predict from data using knowledge, rules, and patterns [15,16]. Machine learning, introduced by IBM in 1958 [17], aims to automate the ability to learn and discover patterns hidden in the data [2,17]. Deep learning improves the automation of the ability to learn using neuro networks. Natural language processing automates the ability to understand the natural language. ChatGPT is the latest product of deep learning and natural language processing. All of them aim to facilitate learning intelligence rather than thinking intelligence, understanding intelligence, and connecting intelligence. For example, thinking intelligence

might consist of intelligence from consciousness, curiosity, imagination, deduction, induction, abduction, and more, which will be investigated in another book of mine.

2.3 Intelligence 2.0

Intelligence 2.0 is an augmented intelligence from human intelligence. Intelligence 2 is a kind of intelligence towards knowledge innovation and creation, that is, innovative intelligence and creative intelligence. All of them have been used in teaching and research, for example. Meta intelligence belongs to intelligence 2.0. Intelligence 2.0 at least consists of intelligence of consciousness, curiosity, association, imagination, originality, deduction, induction, and abduction [18]. In other words, intelligence 2.0 is advanced. The best examples of intelligence 2.0 include business intelligence, emotional intelligence, marketing intelligence, service intelligence, analytics intelligence, organizational intelligence, and so on [13,19]. Collaboration, cooperation, and coordination as collective intelligence belongs to intelligence 2.0. System intelligence, platform intelligence, and intelligence of machines are also intelligence 2.0. Finally, intelligence 2.0 is an integrated intelligence.

Currently, AI also focuses on intelligence 2.0, for example, the Internet of everything (IoE) intelligence, collective intelligence, system intelligence, platform intelligence, and integrated intelligence [13].

In fact, like knowledge has six different hierarchies, intelligence should be classified into at least 6 levels: intelligence 1.0, intelligence 2.0, intelligence 3.0, intelligence 4.0, intelligence 5.0, and intelligence 6.0 [13]. Then we use meta as an operation such that Meta (intelligence) = intelligence 1.0. Meta (intelligence 1.0) = intelligence 2.0. Meta (intelligence 2.0) = intelligence 3.0. Meta (intelligence 3.0) = intelligence 4.0. Meta (intelligence 4.0) = intelligence 5.0. Meta (intelligence 5.0) = intelligence 6.0 [13]. We leave them as future work. Therefore, we only look at above mentioned intelligence 1.0 and intelligence 2.0 hereafter.

3. Intelligence of five senses and our body

We have five senses: see, hear, smell, taste, and feel [20]. AI has imitated, simulated, and augmented each of them and led five intelligences: Seeing intelligence, hearing intelligence, smelling intelligence, tasting intelligence, and feeling intelligence. We can move, learn, think, understand, and write. AI has also imitated, simulated, and augmented each of them and led another five intelligences: moving intelligence, learning intelligence, thinking intelligence, understanding intelligence, and writing intelligence [21]. For example, the representation form of AI for these five intelligences, in particular, intelligences of our body including speaking intelligence, reading intelligence, learning intelligence, moving intelligence, understanding intelligence, and writing intelligence [21], all of ten intelligences are listed in **Table 1**.

This implies that AI has impacted every part of our body and imitated, simulated, and augmented it. In fact, the basic skills and intelligences of human beings have been mimicked, augmented, simulated, and augmented since 1956. AI first focused on human-centered intelligences, and then human-centered intelligences for her/his activities.

Furthermore, AI research aims to imitate, augment, extend, and surpass the intelligence of human beings. The form for showing intelligences of human beings is that it can see, listen, talk, read, speak, move, think, learn, understand, and write, what humans can. All the intelligent systems like to say "I can too". I can do it much better than the human beings [21]. From a human viewpoint, AI has been promoted towards human-centered intelligence development since 1956.

AI can see, based on image recognition, literal or letter recognition, and label (car) recognition.

Table 1. Intelligences of our body.

Human Body Parts and Functions	The state of Art AI for Human Body Parts and Functions	Remarks
Listen and Hear	Speech recognition, speaker recognition, machine translation	Hearing intelligence
Smell	Artificial networks learn to smell like the brain. How AI can detect and identify Smell	https://news.mit.edu/2021/artificial-networks-learn-smell-like-the-brain-1018 https://nttdata-solutions.com/sg-en/blog/how-ai-can-detect-and-identify-smell/ Smelling intelligence
Taste	Best Taste Intelligence Companies	https://www.cbinsights.com/esp/consumer-&-retail/digital-engagement Tasting intelligence
Feel	As a part of emotional intelligence	Feeling intelligence
See	Image recognition, text recognition, license plate recognition	Seeing intelligence
Speak	Speech synthesis voice synthesis, dialogue between human and machine	Speaking intelligence
Move	Robots, EV car, driverless car, drone Airplane, highspeed train,	Moving intelligence
Think	Human-computer chess, theorem proving, medical diagnosis	Thinking intelligence
Learn	Machine learning, knowledge representation	Learning intelligence
Understand	Natural language understanding, Grammarly	Text translation, text proof-reading, Understanding intelligence.
Write	ChatGPT 4, Natural language understanding	Writing intelligence

AI can hear based on voice recognition, dialogue recognition, and machine translation.

AI can speak based on voice synthesis, and dialogue between humans and machines.

AI can move based on driverless cars, and drones.

AI can think based on games between humans and machines, theorem proving, and medical diagnosis.

AI can learn based on machine learning, and knowledge representation.

AI can understand based on language understanding and processing.

AI can write based on many handwriting methods, for example, we can use Word to write, we can use Grammarly to review what we have written, and remove type-setting errors. There are many handwriting methods. Your finger is the most important writing tool, more than your pen writing method.

Recently, ChatGPT has helped us to think, learn, understand, and write toward the completeness of academic reports, article, and theses. Some have used ChatGPT to write academic reports, theses, and books. However, there is a long way toward imagination and association driven reports, article, and theses.

This is why only AI is not enough. In fact, we need more intelligences to augment basic skills and intelligences of our feet and heads.

4. Artificial feet and artificial heads

AI is becoming a core business, governance, and analytic competency to transform business processes, reconfigure workforces, optimize infrastructure, blend industries, bring about digital leadership, and 3D print digital leaders to lead the world shortly [11]. Artificial feet represent the scientific inquiry into imitating, augmenting, and automating human feet and their functions throughout this research, different from the current usage of artificial feet for medical services. This section examines artificial feet and looks at the evolution from artificial feet to artificial brains. The research reveals that artificial feet are one of the origins of the Industrial Revolution and a real foundation of AI. The study demonstrates that AI will play a critical role in making artificial feet, hands, mouths, eyes, ears, and brains more intelligent.

4.1 Artificial and intelligence

Intelligence in AI is not important, because human beings have discussed intelligence in the past 2000 years [13]. Artificial is new for human beings thanks to advanced technologies. Therefore, the importance of AI comes from the artificial and its combination with intelligence in 1956 by John McKinsey [2]. Further, when we deeply think about AI, we might first ask.

- What are artificial feet?
- What is the relationship between artificial feet and AI?

This section will address these two problems and have three key contributions. The first key contribution is to reveal that artificial feet are one of the origins of the Industrial Revolution. The second key contribution is that the evolution of artificial feet provides a new way for current AI. The third key contribution is that artificial feet are the real foundation of AI.

The remainder of this article is organized as follows: Section 2 looks at artificial feet. Section 3 discusses the evolution from an artificial hand to an artificial brain based on the principle of "liberation from bottom to top and control from top to bottom of a human body". Section 4 discusses how to apply AI to artificial feet and brains.

4.2 Artificial feet

According to an English Dictionary, the foot is the lowest part of the leg, below the ankle, a person or an animal stands, walks, runs, and flies. In other words, the feet are the most important part of the human being as an animal. Without feet a few hundred years ago, for example, 500 hundred years ago, one could only stay home within a village. This is why someone wrote a poem at that time and dreamed that "I hope to have a pair of wings to fly to where I like". Later, a Chinese writer Wu, Chengen published a novel "Journey to the West" (Xiyou ji) in the 16th century. (https://en.wikipedia.org/wiki/Journey_to_the_West, retrieved on 08 July 2014). The novel is a comic adventure story, a humorous satire of Chinese bureaucracy, a spring

of spiritual insight, and an extended allegory in which the group of pilgrims journeys towards enlightenment by the power and virtue of cooperation. For example, it describes that the Master Sun could fly tens of thousands of miles within seconds. Master Sun was the representation of light because light can travel about 300,000 km per second. This story implies that the human being had a dream to fly in the sky at least in the 16th century. In other words, human beings like to have artificial feet and legs or intelligent feet and legs to fly already for five centuries.

In contrast to the current usage of artificial feet for medical services, artificial feet are used to represent the scientific inquiry into imitating, augmenting, and automating human feet and their functions hereafter. The main function of artificial feet is to move from one place to another. In what follows, this article only discusses the development of artificial feet since the Industrial Revolution.

Bicycles were introduced in the late 19th century in Europe [22] and are popular artificial feet for recreation and transportation.

Car was introduced in 1886 and became popular in the early 20th century and now is a necessary artificial foot in modern society [23]. It not only mimics and automates but also augments the human feet successfully. Currently, a person can use his feet to walk 5 km per hour, whereas, s/he can drive the car on the highway at a speed of 120 km per hour. Therefore, cars dramatically augment the speed of human feet.

The train is another artificial foot invented in 1784. Now it is an important transportation system [24]. If one goes to Shanghai from Beijing on foot, one needs to take a few months. Nowadays, one takes a high-speed train, and uses 4 hours and a half to get there. Therefore, trains have mimicked, augmented, and automated human feet. From an AI viewpoint, trains are not only artificial feet but also intelligent feet although no researchers consider trains in such a way. They intentionally leave the space for AI to use intelligent transportation systems (see Section 5).

The airplane is an artificial foot. It not only mimics, augments, and automates the jump function but also the fly function of human feet. The airplane is the first step for realizing what Master Sun did in the mentioned Chinese novel.

The rocket is another artificial foot. It not only mimics, augments, and automates the jump function but also realizes the fly function of human feet. It can jump and fly into the outer space. For example, the astronauts took the rocket as artificial feet to visit the moon in the 1960s. The rocket played the same role as the feet of the astronauts so that they could fly from the Earth to the Moon and come back to Earth. Therefore, the rocket has realized what Master Sun did in the mentioned Chinese novel.

Digital signals based on light are the most powerful artificial feet. A digital signal is a signal that is being used to represent data as a sequence of discrete values; at any given time it can only take on one of a finite number of values [25]. Have an imagination, we go to the USA from China on our feet, then visit Amazon company and buy a book on artificial feet. The CEO of Amazon tells us that you need not come here, please go home and you can receive the digital book from your computer at your home in China. You say "Really?". This means that the digital signal of the Internet has replaced your feet and augmented the function of your feet: movement. The light signal transmission has completely realized what Master Sun did in the mentioned Chinese novel. **Table 2** lists all the artificial feet in this section.

Table 2. Various kinds of artificial feet.

artificial feet	Invention time	Current speed km/h	Remarks
Bicycle	1847	15.5	Also a transportation tool
Car	1886	120	Excellent artificial feet
Train	1784	350	It becomes an enjoyment tool.
Airplane	1903	955	Learn from Master Sun
Rocket	1200's	7.9 km per second	Did like Master Sun
Light	N/A	299 792 458 m / s	Did as Master Sun
Digital Signal	Gene Frantz	$(2.87 \pm 0.03) \times 10^8$ m/s	Faster artificial feet

The above discussion leads to the following:

a. The mentioned artificial feet and their evolution are the results of the Industrial Revolution in the past four centuries.

b. If bicycles, cars, trains, airplanes, rockets, and digital signals are artificial feet, then each of them is also intelligent feet based on the principle of AI.

c. If every artificial foot mentioned above is an intelligent foot, then research and development of artificial feet and intelligent feet are much earlier and wider than AI.

d. The current advance of AI in driverless cars should have been the further step of artificial feet [11], although no people promote driverless cars to the market in such a way.

The above discussion raises a research problem: How can we change our research direction of AI based on the development of artificial feet? In other words, what lessons learned from the above intelligent feet can be used to further develop current market-oriented AI.

4.3 From artificial hands to artificial brains

This section looks at the evolution from artificial feet, via artificial hands, artificial mouths, artificial eyes, and artificial ears, to artificial brains since the Industrial Revolution. This evolution follows the principle of liberation from the bottom to the top of the human body, illustrated in **Figure 1**. Reversely, artificial development follows the principle of "control from top to bottom" of a human body. The evolution of the Industrial Revolution always focuses on the human-centered artificial development to liberate the human being from the feet to the brain, and then at the same time, to control the human being from the brain to the feet, not only artificial brain and feet but also physical brain and feet. AI, artificial mind, and artificial wisdom are only further continuous development based on the updated principle: intelligent liberation from bottom to top, and intelligent control from top to bottom, as shown in **Figure 2**, which led the author to the journey of AI from nothing.
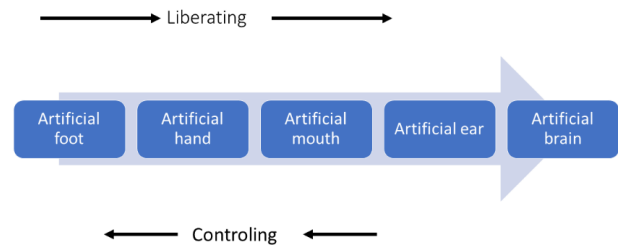

Figure 1. From artificial feet to artificial brain.

In what follows, we will delve into each of them.

Artificial hands

Artificial hands refer to the scientific inquiry into imitating, augmenting, simulating, and automating the human hand and its functions hereafter [13].

The main function of an artificial hand is to carry things from one place to another. Therefore, any transportation tool is a realization of "imitating, augmenting, and automating human hand", because transport aims to move humans, animals, and goods from one location to another using various tools [26]. The modes of transport include air, land (rail and road), water, cable, pipeline, and space. The transportation tools for each mode include

Air: network, the internet, airplanes, rockets, drones, and helicopters.

Land (rail and road): trains, trucks, buses, cars, bicycles, elevators, and escalators.

Water: watercraft, ships, and aircraft carriers.

Cable: electronic communication cable transmit the voice message, computer data, and visual images via electronical signals to telephones, wired radios, TV and cable TV, computing machineries such as laptops, desktops, and smartphones.

Digital: network, the internet, computers, mobile phones, smartphones, radio, and interactive TV.

Pipeline: Oil pipeline, water pipeline, and sewage pipeline.

Space: Spacecraft.

All the kinds of artificial feet mentioned in the previous section are also artificial hands for carrying things from one place to another. All the mentioned artificial hands have improved the intelligence of human beings since the Industrial Revolution and liberated human hands from heavy carrying. Some

of them such as trains and ships can carry thousands of millions heavier than a human can. Therefore, they are not only artificial hands but also intelligent hands. However, nobody recognized the current high-speed train as an artificial hand and an achievement of AI. This is the tragedy of the history of AI. This also shows that the research and development of artificial hands and intelligent hands are much earlier than that of AI. The former started in the early stage of the industrial revolution.

Artificial mouths

Artificial mouth refers to the scientific inquiry into imitating, augmenting, simulating, and automating the human mouth and its functions.

The main function of an artificial mouth is to speak to others as far as possible and get what one said understood as much as possible.

The artificial mouth includes a loudspeaker which converts an electrical audio signal into a corresponding sound [27]. Another is a computer speaker. The smartphone has installed a special speaker, we can consider the smartphone speaker as an artificial mouth.

The loudspeaker can augment the function of the human mouth significantly. The computer speaker, mobile phone speaker, radio, and TV enable everyone in one corner of the world speak to others in another corner of the world. The author can use a smartphone in Australia to chat with his family members in China and the USA. These artificial mouths ignore the limitations of distance and time. Therefore, we can consider loudspeakers, computer speakers, and mobile phone speakers as intelligent mouths. AI has helped artificial speakers with the intelligent technique of natural language understanding and processing [2,13].

Artificial ears

Artificial ear refers to the scientific inquiry into imitating, augmenting, simulating, and automating the human ears and their functions hereafter. The main function of an artificial ear is to listen to what others speak as far as possible. The artificial ear is

a telephone and microphone, both are a transducer that converts sound into an electrical signal. Voice recorders are also artificial ears. One can listen to the voice from TV sets, radios, smartphones, and other digital devices. The voice was recorded many decades ago from any corner of the world. Therefore, artificial ears are really intelligent ears in the digital world.

Artificial eyes

Artificial eye refers to the scientific inquiry into imitating, augmenting, simulating, and automating the human eye and its functions hereafter. The main function of the artificial eye is to see things clearly as far as possible.

Cameras, camera recorders, and CCTV systems are all artificial eyes. Nowadays, one can see what happens anywhere and at any time through TV, smartphones, and computers. Therefore, TVs, smartphones, and computers are also artificial eyes. Artificial eyes are intelligent eyes if AI has been driven.

Artificial brains

Artificial brain refers to the scientific inquiry into imitating, augmenting, simulating, and automating the human brain and its functions hereafter. The main function of an artificial brain is to control all the parts, in general, and feet, hands, mouths, eyes, and ears and their functions of the human body as a human.

The digital computer was named the electronic brain. It is an artificial brain. Now computers, laptops, and smartphones are all artificial brains to replace human brains.

4.4 Applying AI to artificial feet and artificial brains

The previous sections have discussed artificial feet, hands, mouths, eyes, ears, and brains with examples. We can find that smartphones are not only artificial feet, but also artificial mouths, eyes, ears, and brains. This is the way a smartphone has become an organic part of our brain, work, and life.

Furthermore, we find that two issues arise from

the above discussion:

How to make the existing artificial feet, hands, mouths, eyes, ears, and brains more intelligent is a topic for the current AI research and development, as illustrated in **Figure 2**. For example, the remarkable progress of driverless cars is really a part of making artificial feet more intelligent [11,13,28]. Market-oriented AI will play a critical role in making artificial feet, artificial hands, artificial mouths, artificial eyes, artificial ears, and artificial brains more intelligent. The evolution of artificial feet, hands, mouths, eyes, ears, and brains has dominated the core of the Industrial Revolution. Market-oriented AI will usher in the coming of an intelligent society by applying AI to make artificial feet, hands, mouths, eyes, ears, and brains more intelligent.

Another topic for the current AI research and development is how to get heuristics from the evolution of the mentioned artificial feet, hands, mouths, eyes, ears, brains, and develop artificial mind and artificial wisdom to create 3A: AI, artificial mind, and artificial wisdom, which underpin a trinity for the intelligent society in the age of intelligentization (see Section 5).
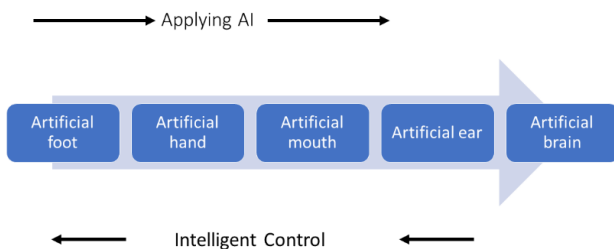

Figure 2. An intelligent model for artificial feet to artificial brain.

5. AI trends and challenges

As AI continues to advance, we must keep up with future trends while preparing for future developments. Many have discussed the AI trends and challenges [9,29,30]. We will also discuss them in the following way to provide an integrated paradigm. There are the following eight AI Treads ahead of us in the following years starting from creative, generative and analytical AI.

5.1 AI treads

Creative, generative and analytical AI

Creative AI can generate music based on existing songs, and techniques to create original soundtracks [31]. AI is used in a creative space and can benefit media industries.

Two definitions are provided here: One is from Mckinsey, and Another is from Gartner: Generative AI is an AI paradigm that generates content in response to a prompt [32]. Generative AI can produce a variety of novel content, such as images, video, music, speech, text, software code, and product designs based on certain styles and criteria [30,32]. Generative AI is an intelligence that can learn from existing artifacts to generate new, realistic artifacts (at scale) that reflect the characteristics of the training data but don't repeat it [30].

One of the current text content generations is ChatGPT. ChatGPT of OpenAI has pushed the further development of generative intelligence in terms of transforming business and its impacts on business and society. Generative AI investment has skyrocketed recently [9]. Analytical AI is an intelligence paradigm that uses analytic models, methods, and techniques to analyticize data and big data, to process information and big information, knowledge and big knowledge intelligently? This is the analytical intelligence [13].

Analytical AI is the core of supporting creative AI and generative AI.

Intelligent and autonomous AI

Future AI systems will be more intelligent and autonomous [29]. With the continuous advancement of deep learning, reinforcement learning, and other technologies, AI systems can self-learn, self-optimize, and automatize decision-making without direct human intervention. The example of intelligent and autonomous AI is self-driving (see later).

Furthermore, the multidimensionality, dynamics, diversity, temporality of intelligences will reflect in the AI, human intelligences, machines and systems in the coming years.

Industry continues to dominate frontier AI research

In 2023, industry produced 51 notable machine learning models, while academia contributed only 15 [9]. Further, Nvidia (nvidia.com) AI-driven chips have dominated chip markets [33]. Gartner reported that semiconductors designed to execute AI workloads would represent a $53.4 billion revenue opportunity for the semiconductor industry in 2023, an increase of 20.9% from 2022. This double-digit growth will continue at 25.6% in 2024 to $67.1 billion [33].

Perhaps only Huawei can compete with Nvidia shortly. However, like smartphones in China, as soon as the companies master the technologies of chips, they will boom.

Finally, almost all intelligent products and services are based on chips and AI-driven chips. For example, the average modern car has between 1,400 and 1,500 semiconductor chips. Some cars can have as many as 3,000 chips (https://www.icdrex.com/how-many-semiconductor-chips-in-a-modern-car/, retrieved on 8 07 24).

China dominates industrial robotics

An industrial robot is an automatically controlled, reprogrammable multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or fixed to a mobile platform for use in automation applications in an industrial environment [34].

Since surpassing Japan in 2013 as the leading installer of industrial robots [9], China has significantly widened the gap with the nearest competitor nation. In 2013, China's installations accounted for 20.8% of the global total, a share that rose to 52.4% by 2022.

Integration between AI, human intelligences, machines, and systems

In the years to come, the new system of integrating AI, human intelligence, and machines will be reflected in cloud computing [13]. In cloud computing, AI and human Intelligences have been integrated into machines and systems. Furthermore, the Internet of Everything (IoE), the Internet of Things (IoT), the Internet of People (IoP), and the Internet of Services (IoS) have been integrated with AI. Therefore,

Intelligent IoE = Intelligent IoT + Intelligent IoP + Intelligent IoS

will dominate the cloud and the intelligent IoE [13].

More generally, intelligent applications have learned adaptation capabilities to respond appropriately and autonomously [33]. Numerous use cases may require these applications to augment or automate work and life. Consequently, intelligent applications deliver AI-based systems, products, services, and experiences that dynamically adapt to organisations and users.

Informatization, digitalization, networking, and intelligentization

Informatization aims to apply information technology and systems to all fields so that the information can be acquired, processed, stored, and transmitted effectively and efficiently [35].

The main task of information systems is to transform data into information [13,15]. The research and development of information systems have been at least 70 years old. Now integrating big data within information systems is to promote the further development of informatization of big data [13]. Informatization of big data will also become more and more important, and the value of information is becoming more and more important [36].

Digitalization aims to transfer data and information into a digital form to process and analyse them [35].

The inception of the Internet in the world in the middle 1990s has led to the booming of e-commerce and electronic services. Amazon was the first online bookseller now an empire for selling almost everything. Alibaba is also a big winner in e-commerce and electronic services. China is still springing up in this area and developing its e-commerce and e-service in every corner of its countryside. JD.com, Pinduoduo, TikTok, and Tencent have also become international companies and provided e-services and cloud services globally [13].

In recent years, IoE, IoT, IoP, and IoS have flourished globally. All these show that the networking

of data and intelligent networking are becoming significant. In the near future, everything we have (furniture, electrical appliances, cars, drones, health, smartphones) will be connected to the Internet, and the cloud, our brain, and many parts of our body will be automatically connected to the Internet, all these are underpinned by the intelligent networking of big data as an infrastructure. Therefore, the intelligent networking of big data is the basis of mining big data for big intelligence, mining big data for everything, and is also an important infrastructure for smart communities, smart cities, and smart countries [13].

Intelligentization aims to make computing systems intelligent. For example, self-learning, reasoning, judgement, and decision making has been properties of intelligent systems [35].

The main task of data-based AI is to discover intelligence from big data [37]. This can be called data intelligence. The advances of driverless cars, drones, and ChatGPT are examples of this trend. The perseverance of human beings in liberating their intelligences is an important basis for the development of mining big data for big intelligence. Everyone wants to be smart, intelligent, and more intelligent than others. Intelligent chips, AI machines, and intelligent systems are already ubiquitous in the market. Mining big data for big intelligence is not only important for all countries in the world. In the next few decades, more and more countries and individuals will struggle for and benefit from mining big data for big intelligence, mining big knowledge for big intelligence, and mining big intelligence for big wisdom [13].

As a hybrid form, intelligent digitalization aims to realize data-driven decision-making and business optimization based on digitalization and integration of AI, big data, and cloud computing [35].

Overall, informatization is the basis, digitalization and networking are the means, and intelligentization is the goal. Intelligent digitalization and networking are our expectations for the digital world [35].

AI, Manufacturing and intelligent manufacturing

Intelligent manufacturing will have three basic paradigms based on the manufacturing evolution as shown below.

a) Digital manufacturing

$$\text{Digital manufacturing} = \text{digital} + \text{manufacturing} \tag{1}$$

This is the first stage of manufacturing since the digital revolution in 1946. Digital machines and tools have been filled in the market. Traditional cars are also digital cars although we do not call them.

b) Digital networking manufacturing

$$\text{Digital networking manufacturing} = \text{digital} + \text{networking} + \text{manufacturing} \tag{2}$$

This is the second stage of manufacturing since the inception of the Internet in the middle of 1990. All the online systems and cloud systems are examples of this digital networking manufacturing. Social networking systems such as Facebook, WeChat and WhatsApp are examples of digital networking manufacturing.

c) Intelligent digital networking manufacturing

$$\text{Intelligent digital networking manufacturing} = \text{Intelligent} + \text{digital} + \text{networking} + \text{manufacturing} \tag{3}$$

This is the third stage of manufacturing also since the inception of the Internet because AI has been there to apply to digital networking manufacturing. The recent development of this stage is that AI, big data, Internet, multimedia sensors, human machine interfaces, and self-devices are integrated to develop intelligent digital networking manufacturing.

Personalization, customization and mass production

AI will increasingly dominate the field of personalized user experience [38]. Advanced algorithms can analyze user behaviors, preferences and historical data to provide hyper-personalized content, product recommendations, and services. AI can enable the customers' services based on big data and big recommendations and realize personalization. One can receive intelligent recommendations from WeChat, WhatsApp, and Amazon.

AI can more accurately understand user needs and provide personalized services and products. AI can provide customized services based on each person's characteristics and preferences. By analyzing user behaviors and preferences, AI enables e-commerce platforms and social media to recommend products and services to the customers that are most likely to appeal based on their search history and previous purchases [31]. The author has received automatic recommendations from WeChat and Amazon and ask him what he really need for the next step.

Even so, mass production of cloud AI goods and services will be still a big trend for global companies. Mass production still dominates the market of AI, for example, NVIDIA AI-driven chips have increased their shares and chips dramatically.

5.2 Challenges to AI

AI also faces challenges in the future. The challenges are below:

Privacy, safety and security

Data security and privacy protection issues are becoming increasingly prominent with the popularity of AI-driven products and services. If AI products and services are ubiquitous, then so are AI frauds and deceptions. How to ensure that AI systems follow privacy protection principles when using data and preventing data leakage and abuse is an important challenge facing the development of AI systems, products, and services. How to protect one's privacy, and keep one's safety and security become also important [13].

In 2023, the security and safety of AI systems sparked significant debate, particularly regarding the potential extreme or catastrophic risks associated with advanced AI [9].

AI ethics, responsibility, and law

AI's decision-making and behavior may raise several ethical and moral issues. For example, when a self-driving car faces an unavoidable collision, who should be protected first? Which is responsible for the unavoidable collision: Software, hardware, chips, and algorithms. Finally, it is difficult to judge who will be responsible.

The general publics, organizations, and governments are concerned about misuse and misinformation in the big data and AI-driven society [33,39].

Business leaders and policymakers call for regulation and guardrails to ensure responsible AI use.

Responsible AI refers to that AI models, algorithms, machines, and systems can provide clear explanations for their decisions [38]. Explainable AI will become an important challenge.

In 2023, there were 25 AI-related regulations, up from just one in 2016. Last year alone, the total number of AI-related regulations grew by 56.3% [38].

AI and healthcare

In healthcare, MYCIN as an expert system was developed for medical diagnosis & treatment in the 1970s [2], and Watson of IBM as an expert system focused on hypothetical lung cancer diagnoses in the last decade [13]. Recently, Deepmind's Stream's AI system can automatically scan and identify MRI and CT and other medical imagining data. AI helps medicine take significant strides forward [9]: EVEscape enhances pandemic prediction. AlphaMissence assists in AI-driven mutation classification. Oncology AI systems can use the symptoms and genetic information to help doctors provide personal treatment recommendations.

The use of AI for description, diagnostics, prognosis, and prescription have proliferated descriptive, diagnostic, predictive, and prescriptive analytics [13]. Advanced algorithms of AI can analyze medical images, genetic data, and patient records to aid in early disease detection, personalized treatment plans, and more accurate prognosis [38]. This AI will revolutionize healthcare and medical treatment by improving diagnostic accuracy and treatment effectiveness.

AI and transportation

AI is also expected to play a crucial role in intelligent transportation [31]. For example, self-driving. Self-driving has become popular in many countries. Driverless cars can use AI recognition, sensing and

decision-making, and self-driving to improve the moving rate. Tesla and BYD are the best competitors in the market. Xiaomi and Huawei (Wenjie) are the important challengers. More highly advanced technology cars will come in the future. Tesla, BYD, Xiami, Huawei, and more are booming in China. Who will be the winner in ten years? The US government and EU know? because the US government uses tariffs of 100% for EV Cars in China, whereas the EU uses tariffs of 38% for EV Cars in China. One will find who will dominate the world. This is why some countries are concerned about the fall of their future, just like cars. As soon as the EV Cars of China dominate the world, one can enjoy the cheapest cars running the world. Maybe you can buy an EV car with $10,000.

Intelligent control

Intelligent voice assistant or Smartphone APP of Xiao Mi' Mi AI Apple's Siri and Amazon's Alexa can control voices, lights, temperature, and other devices.

Intelligent drones have been flying in the sky for entertainment, services, and military actions.

All these illustrated that intelligent AI apps and tools are around us. More intelligent AI tools and systems are coming.

Automata of home services

AI-driven washing machines have been used for decades. The AI-driven robot cleaners of Xiaomi have been used by many families. AI-driven tea services for businessmen have been used in Japan (NHK). More intelligent automatic machines have been used for home services, for example, AI-driven smartphones are already in the market, IoS, Harmony and Android will also win the smartphone market. Who is the winner? Maybe one big company will be bankrupt very soon. This is not an age of "too big to fail".

6. Conclusions

Few researchers provide a wider vision of artificial feet, hands, mouths, eyes, ears, and brains, few consider a train to look like artificial feet. This limits our vision and their significant impacts on the history of the modern Industrial Revolution and digital revolution. This article presents a novel perspective on human-centered social development starting at artificial feet. This article explores the age of AI and artificial feet, hands, mouths, eyes, ears, and brains and the intelligences of our bodies. It also discusses how to apply AI to artificial feet and artificial brains. The research reveals that artificial feet are one of the origins of the Industrial Revolution and a real foundation of AI. The research demonstrates that AI will optimize artificial feet, hands, mouths, eyes, ears, and brains in the digital age. Finally, this research also looks at AI's trends and challenges shortly.

In future work, we will delve into the intelligences between human beings and their environment based on the existing AI's trends and challenges to sketch the more beautiful picture for understanding human-centered AI development.

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